Determination of Reinforcer Value in Rats With an Adjusting-Delay Choice Procedure Involving a Correspondence Between Location and Amount of Reinforcement

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Introduction

The ability to discount an immediate reward seems contrary to the natural drives of animals, which are based on impulsive behavior and a tendency to obtain resources without delay. By obtaining a particular resource immediately, an animal is able to utilize it before it decays, becomes rotten, or ultimately perishes.

Logue (1995) hypothesized that the ability to inhibit impulsive tendencies and to utilize self-control has evolved in humans. Logue (1995, p. 7) defines impulsiveness as "the choice of the smaller, less delayed outcome" and self-control as "the choice of the larger, more delayed outcome". But to what extent do less intelligent animals display the capacity to defer gratification?

The objective of the current experiment was to assess self-control in rats, and to evaluate a quantitative model that includes a delay-of-reinforcement parameter. Mazur's (1997, 2001) model describes the value of a reinforcer as a function of (1) reinforcer amount, and (2) the delay between a choice response and reinforcer presentation. Specifically, this model asserts V = A /(1 + KD), where *V* represents reinforcer value, *A* is reinforcer amount, *K* is a free parameter, and *D* is the delay between a choice and presentation of reinforcement. According to this model, an animal should value a large delayed reinforcer more than a small immediate reinforcer. However, as the delay between choices and presentation of the large reinforcer increases, eventually, an animal should value the small reinforcer more highly— and its choices will appear impulsive.

Another objective of the current research was to develop a choice procedure that would yield more reliable estimates of indifference points than those reported by other investigators (e.g., Linwick & Hohn, 2003). For purposes of this experiment, "indifference point" was operationally defined as the delay at which a large delayed reinforcer and a small more immediate reinforcer were chosen equally often.

Method

Each of four rats received discrete-trials discrimination training. Discrimination trials involved a choice between three cue lights flashing simultaneously and three cue lights flashing sequentially. These stimuli were presented at the back of nose-poke access holes located to the left and right of a lever, which was mounted on the front wall of an operant chamber. The two stimuli were correlated to different amounts of reinforcement (1-pellet versus 4-pellets of food), and subjects chose a particular stimulus by poking it with their nose. The delay between choices and presentation of reinforcement was longer for the stimulus correlated with multiple food pellets, and choosing this stimulus served to increase the choice-reinforcer delay on subsequent trials.

Configuration of Operant Chamber

Pure tone stimuli bridged the delay between choices and reinforcer presentation; the delay between choices and presentation of multiple pellets was filled with a 4,500 Hz tone, whereas the delay between choices and presentation of a single pellet was filled with a 2,900 Hz tone. Notably, the side of the chamber on which a particular stimulus was presented (left versus right) was counterbalanced across subjects— as was the correspondence between side of chamber and amount of reinforcement (1-pellet versus 4-pellets of food).

The indifference point between a short-delay small reinforcer and a longer-delay large reinforcer was estimated repeatedly at each of several fixed, small-reinforcer delays. The fixed delays employed were 1, 2, 4, 8, and 16 seconds .

Results

Mazur's model of reinforcement value predicts a linear relationship when indifference points are plotted at various small-reinforcer delays; specifically, a line with a slope greater than one and a positive y-intercept. Figure 1 depicts mean indifference estimates for the fixed small-reinforcer delays employed; that is, adjusting delays at which the stimulus correlated with a small reinforcer and the stimulus correlated with a large reinforcer were equally valued. All rats tolerated longer delays between choice responses and presentation of the large reinforcer at longer small-reinforcer delays. That is, rats exercised greater self-control when the wait for the small reinforcer was relatively long.

Because the data are presented for individual subjects and training is in progress, none of the coordinate systems displayed in Figure 1 contain indifference estimates for every fixed, small-reinforcer delay.

Although the current results are preliminary, the y-intercepts of the regression lines indicate that the value of a small reinforcer after a 0-sec delay is equal to that of a large reinforcer after approximately 80 sec. The slopes of these lines are also noteworthy, and indicate that for every 1 sec increase in the wait for a small reinforcer, subjects waited approximately 4 additional seconds for a large reinforcer.

Standard deviations were calculated for each of the mean indifference estimates depicted in Figure 1. These standard deviations ranged from 2.83 sec to 31.26 sec. The proportion of variance in the adjusting-delay measure that was accounted for by its linear relationship with the fixed-delay measure was also calculated for each subject. These proportions ranged from .63 to .95.

Discussion

All rats preferred waiting for a large amount of food (4 pellets) to the immediate receipt of a small amount of food (1 pellet)— provided that the wait for the large amount was not too long. In addition, when the wait for 1 pellet of food was increased, rats chose to wait even longer for 4 pellets of food. Thus, all subjects displayed self-control.

The current results support Mazur's model of reinforcement value. As noted previously, this model predicts (1) a linear relationship when indifference estimates are plotted at various small-reinforcer delays, and (2) a regression line with a slope greater than one and a positive y-intercept. Both of these predictions were confirmed. Moreover, indifference estimates obtained in the current experiment were less variable than those reported by Linwick and Hohn (2003).

The adjusting-delay choice procedure used in this experiment could be used to evaluate the impact of various drugs on self-control. For example, self-control could be operationally defined in terms of the parameter *K* in Mazur's model of reinforcement value, and the effects of certain drugs (e.g., opiates) on this parameter could be assessed. Future research may focus on such pharmacological effects— both acute and chronic.

References

Linwick, D. C., & Hohn, D. (2003, May). *Determination of reinforcer value in rats with a discrete-trials adjusting-delay choice procedure.* Poster session presented at the annual meeting of the Midwestern Psychological Association, Chicago, IL.

Logue, D. W. (1995). Self-control: *Waiting until tomorrow for what you want today*. Englewood Cliffs, NJ: Prentice Hall.

Mazur, J. E. (1997). Choice, delay, probability, and conditioned reinforcement. *Animal Learning & Behavior*, *25*, 131-147.

Mazur, J. E. (2001). Hyperbolic value addition and general models of animal choice. *Psychological Review*, *108*, 96-112.

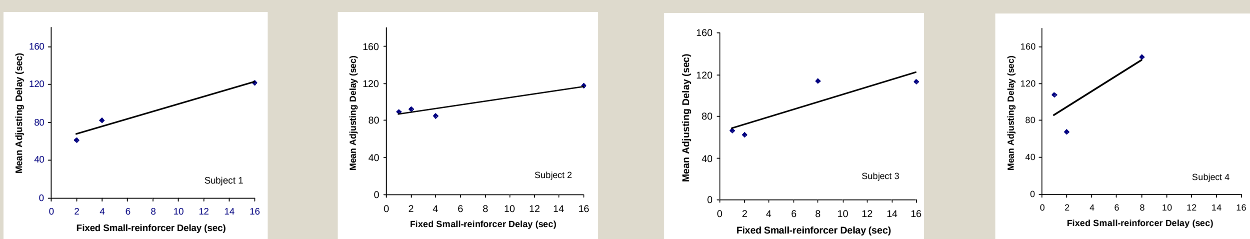

Figure 1. Adjusting delays at which the stimuli correlated with small and large reinforcers were equally valued.